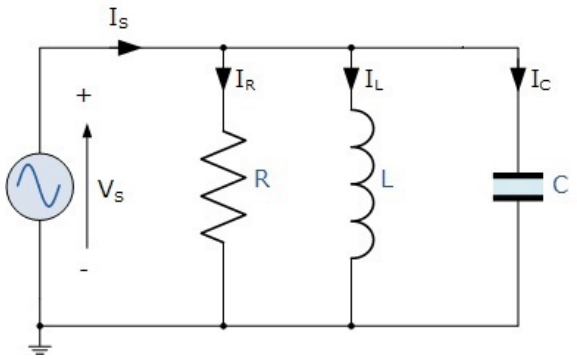
EE2021 Computer Tools for Electrical Engineering
Project 2
Due: December 26, 2018 13:30

Please compress all of the m files, fig file, MULTISIM file and docx to "ee2021_project2_name_surname_studentno.zip", and send it to ee2021projects[at]gmail.com until due date and time.
Also, hand in the hard copy version of your project report to Asst. Prof. Onur Cihan until due date and time.

There are two questions in this project.

1) (70 pts) Consider the electrical circuit given below where three basic circuit components are connected in parallel and powered by a sinusoidal voltage source.



The governing equations of a resistor, a capacitor and an inductor are as follows:

$$V_R = I_R R, \qquad V_L = L\frac{di_L}{dt}, \qquad i_C = C\frac{dV_C}{dt}$$

Since all components are connected in parallel with the voltage source, we have $V_S = V_R = V_L = V_C$ and the currents flowing through them can be computed as

$$i_R = \frac{V_S}{R}, \qquad i_L = \frac{1}{L}\int V_S dt, \qquad i_C = C\frac{dV_S}{dt}.$$

From Kirchhoff's current law (KCL), the current supplied by the source is simply sum of these currents, i.e.,

$$I_S = i_R + i_L + i_C = \frac{V_S}{R} + \frac{1}{L}\int V_S dt + C\frac{dV_S}{dt}$$

In this project, the expression for the voltage source is given as $V_S = 220\sqrt{2}\sin(2\pi ft)$. Then the expression for the current can be computed as

$$\begin{aligned} I_S &= \frac{V_S}{R} + \frac{1}{L}\int V_S dt + C\frac{dV_S}{dt} \\ &= \frac{220\sqrt{2}\sin(2\pi ft)}{R} - \frac{110\sqrt{2}\cos(2\pi ft)}{\pi fL} + 440\sqrt{2}C\pi f\cos(2\pi ft). \end{aligned}$$

Since all components are connected in parallel, the equivalent impedance of the circuit can be computed as $Z_{eq} = \dfrac{1}{\dfrac{1}{R} + \dfrac{1}{j2\pi fL} + j2\pi fC}$, which is a complex value.

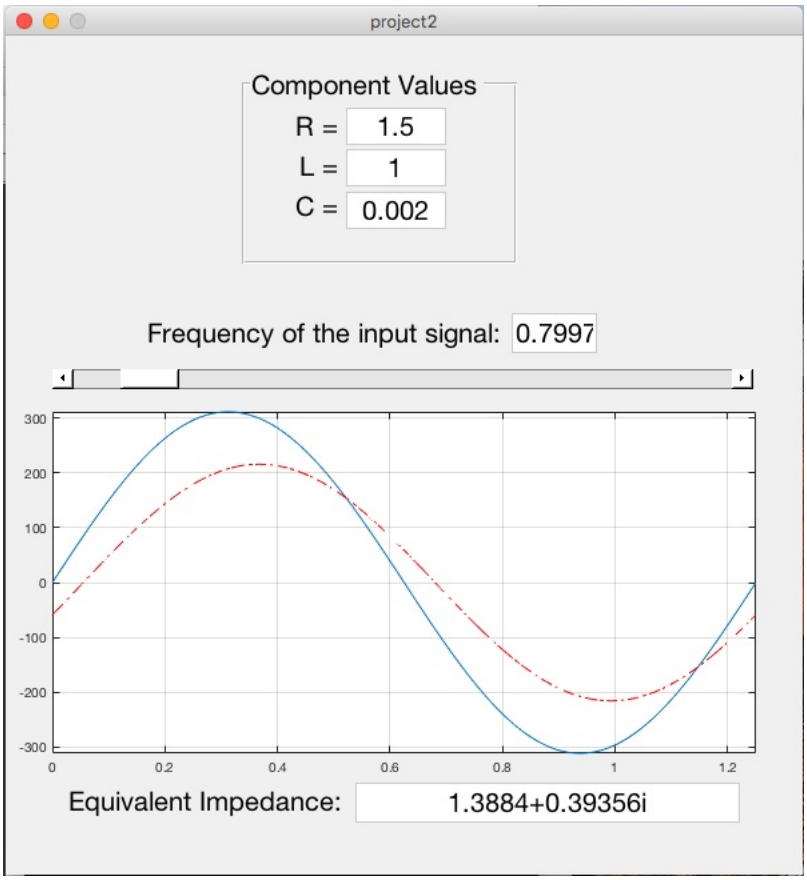
In this part of the project, you are interested in the effect of the frequency of the source

i) on the phase difference between the voltage waveform and the current waveform, and

ii) on the equivalent impedance of the circuit.

To investigate these effects, you will use two computer tools: MATLAB and MULTISIM.

a) (50 pts) You will design a MATLAB program with a graphical user interface (GUI) which plots the waveforms of the voltage and the current of the source for any desired component values and frequency. The expected GUI design is as follows:



The user is able to enter different values for the component values R, L and C, and change the frequency of the voltage source (f) by moving the slider to the right and to the left.

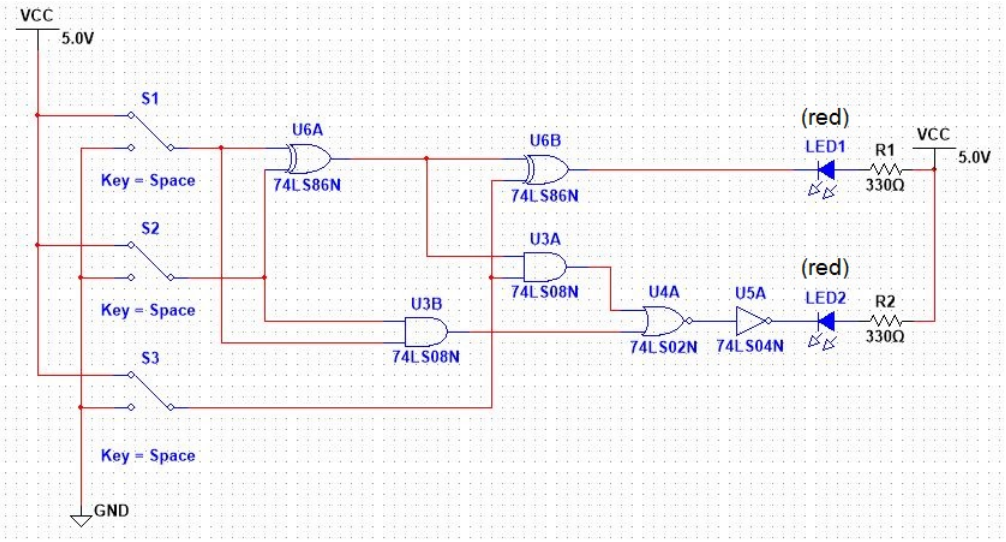
- When the user enters a new value for R, L or C, waveforms of V_S and I_S must be re-plotted using the new values. Furthermore, the equivalent impedance must be re-computed and that value must be shown in the GUI.
- When the user changes the frequency (by moving the slider), waveforms of V_S and I_S must be re-plotted using the new frequency value; and the corresponding frequency value must be shown in the GUI. Furthermore, the equivalent impedance must be re-computed and that value must be shown in the GUI.
- For a combination of R, L and C values, find the frequency for which V_S and I_S are in phase (there is no phase difference between them). What is the equivalent impedance value at that frequency? Write these values and provide a screenshot in the project report.

b) (20 pts) Assemble the same circuit in MULTISIM and obtain the waveforms of V_S and I_S for the values you have found in the first (MATLAB) part. Also, measure

the equivalent impedance of the circuit. If you are unable to complete the first part, you can use the values $R = 3\Omega$, $L = 0.01H$, $C = 0.04F$ and $f = 7.9577Hz$ in your simulation. Your project report must include the waveforms and the equivalent impedance obtained from MULTISIM.

2) (30 pts) In this part of the project, you will assemble the circuit given in the below figure using MULTISIM. Obtain the function of the circuit by completing the table below. In the project report, discuss the implemented function of the circuit (the relationship between the switch positions and the states of LEDs).

S1	S2	S3	LED1 (ON/OFF)	LED2 (ON/OFF)
0	0	0	?	?
0	0	1	?	?
0	1	1	?	?
0	1	0	?	?
1	1	0	?	?
1	1	1	?	?
1	0	1	?	?
1	0	0	?	?



Good Luck!